PATENT COOPERATION TREATY

From the
INTERNATIONAL PRELIMINARY EXAMINING AUTHORITY

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PCT

NOTIFICATION OF TRANSMITTAL OF THE INTERNATIONAL PRELIMINARY EXAMINATION REPORT
(PCT Rule 71.1)

Date of mailing *(day/month/year)*	03.01.2005
Applicant's or agent's file reference: IP/P7155/WOD	**IMPORTANT NOTIFICATION**

International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/GB 03/04447	15.10.2003	19.10.2002

Applicant
QUINTEL TECHNOLOGY LIMITED et al.

1. The applicant is hereby notified that this International Preliminary Examining Authority transmits herewith the international preliminary examination report and its annexes, if any, established on the international application.

2. A copy of the report and its annexes, if any, is being transmitted to the International Bureau for communication to all the elected Offices.

3. Where required by any of the elected Offices, the International Bureau will prepare an English translation of the report (but not of any annexes) and will transmit such translation to those Offices.

4. **REMINDER**

The applicant must enter the national phase before each elected Office by performing certain acts (filing translations and paying national fees) within 30 months from the priority date (or later in some Offices) (Article 39(1)) (see also the reminder sent by the International Bureau with Form PCT/IB/301).

Where a translation of the international application must be furnished to an elected Office, that translation must contain a translation of any annexes to the international preliminary examination report. It is the applicant's responsibility to prepare and furnish such translation directly to each elected Office concerned.

For further details on the applicable time limits and requirements of the elected Offices, see Volume II of the PCT Applicant's Guide.

The applicant's attention is drawn to Article 33(5), which provides that the criteria of novelty, inventive step and industrial applicability described in Article 33(2) to (4) merely serve the purposes of international preliminary examination and that "any Contracting State may apply additional or different criteria for the purposes of deciding whether, in that State, the claimed inventions is patentable or not" (see also Article 27(5)). Such additional criteria may relate, for example, to exemptions from patentability, requirements for enabling disclosure, clarity and support for the claims.

Name and mailing address of the International preliminary examining authority:	Authorized Officer
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PATENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference IP/P7155/WOD	FOR FURTHER ACTION	See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)
International application No. PCT/GB 03/04447	International filing date *(day/month/year)* 15.10.2003	Priority date *(day/month/year)* 19.10.2002
International Patent Classification (IPC) or both national classification and IPC H01Q1/24		
Applicant QUINTEL TECHNOLOGY LIMITED et al.		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.

2. This REPORT consists of a total of 6 sheets, including this cover sheet.

   ☒ This report is also accompanied by ANNEXES, i.e. sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

   These annexes consist of a total of 8 sheets.

3. This report contains indications relating to the following items:

   - I ☒ Basis of the opinion
   - II ☐ Priority
   - III ☐ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
   - IV ☐ Lack of unity of invention
   - V ☒ Reasoned statement under Rule 66.2(a)(ii) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
   - VI ☐ Certain documents cited
   - VII ☐ Certain defects in the international application
   - VIII ☐ Certain observations on the international application

Date of submission of the demand	Date of completion of this report
28.04.2004	03.01.2005
Name and mailing address of the international preliminary examining authority: European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Tx: 523656 epmu d Fax: +49 89 2399 - 4465	Authorized Officer Unterberger, M Telephone No. +49 89 2399-7131

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No. PCT/GB 03/04447

I. Basis of the report

1. With regard to the **elements** of the international application *(Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17))*:

Description, Pages

1, 2, 5, 6, 8-20	as originally filed
3, 4, 4a, 7, 7a	received on 25.09.2004 with letter of 20.09.2004

Claims, Numbers

1-11	received on 25.09.2004 with letter of 20.09.2004

Drawings, Sheets

1/9-9/9	as originally filed

2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

   These elements were available or furnished to this Authority in the following language: , which is:

   ☐ the language of a translation furnished for the purposes of the international search (under Rule 23.1(b)).

   ☐ the language of publication of the international application (under Rule 48.3(b)).

   ☐ the language of a translation furnished for the purposes of international preliminary examination (under Rule 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

   ☐ contained in the international application in written form.

   ☐ filed together with the international application in computer readable form.

   ☐ furnished subsequently to this Authority in written form.

   ☐ furnished subsequently to this Authority in computer readable form.

   ☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.

   ☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. The amendments have resulted in the cancellation of:

   ☐ the description, pages:

   ☐ the claims, Nos.:

   ☐ the drawings, sheets:

5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)).

   (Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.)

6. Additional observations, if necessary:

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes:	Claims	1-11
	No:	Claims	
Inventive step (IS)	Yes:	Claims	
	No:	Claims	1,3-11
Industrial applicability (IA)	Yes:	Claims	1-11
	No:	Claims	

2. Citations and explanations

   see separate sheet

Referring to Item V: Reasoned statement under Article 35 (2) PCT with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. With letter dated 20 September 2004 Applicants filed a new set of claims 1-11 and new description pages 3, 4 and 7.

2. The present application does not meet the criterion set forth in Article 33 (3) PCT because the subject matter of claims 1 and 3-11 does not involve an inventive step as explained below.

2.1 Independent claims 1 and 9

Document D8 discloses, see abstract; Figures 1-3 and paragraphs [0007]-[0011], [0014], [0015] and [0018]-[0022], a base station for communicating signals between an operator and one or more mobile units by means of an antenna system, wherein splitting, combining (e.g. 116, 156) and component signal amplifying (113) means are provided between a transmit circuitry (112) and the component signal passing through its associated radiating element, the splitting and combining means incorporating an interface (150) allowing other operators to be connected simultaneously to the same antenna system, with each operator operating on a different frequency.

The subject-matter of claim 1 therefore differs from this known system in:

(a) additional technical features related to a phased array antenna (modulating means to apply complex weights to the component signals such that summation of the component signals results in the production of an antenna beam direction dependent on the value of the complex weights).

(b) a measurement receiver taking a complex measurement from any component signals in the vicinity of the antenna system and generated by any base station connected to the antenna system,

(c) a data hub passing the measurement to the generating base station to enable phase component signal phase correction.

Features (a) are well-known for phased array antennas, and such phased array

antennas are the preferred and commonly used antenna type at base stations. Therefore, the skilled person would readily implement these features with corresponding beam forming and beam steering effect in the base station as disclosed in D8 (e.g. as part of the transmit circuitry 112).

The problem to be solved by features (b) and (c) is to enable phase component signal phase correction due to changes in feeder length between the base station and the antenna.

The solution proposed in claim 1 of the present application cannot be considered as involving an inventive step (Article 33(3) PCT) for the following reasons.

Document D4 discloses, see especially Figure 4; column 2, line 13-31; column 3, line 12-35; column 4, line 19-46; column 5, line 26-62, a transponder (118) measuring signals coming from the antenna and passing the measurement to the generating base station in order to enable phase corrections due to changes of the feeder length between base station and antenna.

A measurement "in the vicinity of the antenna" is not disclosed literally in D4, but is the most obvious way to measure the signals from the antenna.

A person skilled in the art commissioned with the task of signal phase correction due to changes in feeder length between the base station and the antenna would therefore apply the technical teaching of document D4 and thus arrive at the subject-matter of claim 1.

For the same reasoning claim 1 also lacks an inventive step in the light of disclosure of document D9, see abstract; Figure 1 and 2; page 4, line 1 to page 5, line 33; page 6, lines 7-12 and 29-35, in combination with document D4, see the passages cited above.

The same reasoning applies for corresponding method claim 9.

2.2 Claims 3 and 4 refer to the application of complex weights at IF (claim 3) or RF (claim 4) frequencies. These are the two alternative solutions to apply a complex weight to a signal in a phased array antenna system, which the skilled person would select according the circumstances without the use of inventive skill.

2.3 A vector controller controlling phase and amplitude of a signal, as claimed in claims 5-7, also belongs to the common knowledge for phased array antennas at base stations, see e.g. D1, page 18, line 28-39. The skilled person would in case of need implement these feature with corresponding effect into the system of D8. Therefore, also claims 5-7 lack an inventive step.

A plurality of base stations, as claimed in claim 8, is already disclosed in D8 (see e.g. paragraph [0011]).

2.4 The subject-matter of claim 10 is already disclosed by D9 (see e.g. abstract).

Independent receiving method claim 11 corresponds to transmitting method claim 9. In the field of antennas, the skilled person would readily implement the transmitting method of claim 9 also for receiving. The subject-matter of claim 11 does therefore not involve an inventive step.

(on transmit) or at very low powers (on receive). The use of such systems at high powers can result in the unwanted generation of intermodulation products that can de-sensitise the base station receiver.

Further solutions exist that use electrical phase shifters in the antenna housing, these phase shifters being remotely controllable, and so providing an easy to adjust beam pattern. Another problem with this approach is that any phase shifts will apply to all signals transmitted by the antenna, and all signals received by the antenna. Thus independent control of electrical tilt is not possible.

The above approach to generating a variable angle of electrical tilt may be applied to changing the beam pattern in the horizontal plane, such as may be required when an operator wishes to redirect a beam slightly to adjust cell coverage. Again, the same problems associated with the phase shifters will arise.

It is an aim of the current invention to provide an antenna interface able to provide independent control of antenna parameters that alleviate at least some of the problems of the prior art.

According to the present invention there is provided a base station for communicating signals between an operator and one or more mobile units by means of an antenna system having a plurality of radiating elements, wherein:

the system is arranged to process the signals as a plurality of component signals, each component signal being associated with one or more radiating elements within the antenna system, and

modulating means are arranged to apply complex weights to the component signals such that summation of the component signals results in the production of an antenna beam direction dependent on the value of the complex weights, and

wherein splitting, combining, and component signal amplifying means is provided between the application of the complex weight to the component

signal and the component signal passing through its associated radiating element or elements,

characterised in that:

the splitting and combining means incorporates an interface allowing other operators to be connected simultaneously to the same antenna system, with each operator operating on a different frequency, and the system further includes a measurement receiver, and a data hub, wherein the measurement receiver is adapted to take a complex measurement from any component signals in the vicinity of the antenna system and generated by any basestation connected to the antenna system, and to pass the measurement to the generating basestation via the data hub, to enable phase component signal phase correction due to changes in feeder length between the basestation and the antenna.

The invention is particularly suitable for combining independent signals from different operators, as each operator requires no knowledge of any of the signals but its own, in order to control its beam pattern. An operator can control its beam pattern – either its receive beam or its transmit beam – by means of controlling the complex amplitude (i.e. phase and/or amplitude) of the component signals

Preferably the complex amplitude of the component signals is controlled by means of a vector controller (VC). This is a device that manipulates a signal by summing together amounts of in-phase and quadrature versions of itself, the amount of each decided by means of a baseband or low frequency multiplier signal, which can have a negative value. In this way, full control of the amplitude and phase of the VC output relative to the VC input is possible. However, a VC that is arranged to control, or modulate, only the phase of a signal may be used in some implementations of the invention.

Controlling the component signals in this fashion allows the electrical tilt of the beam on either transmit or receive to be tailored to the requirements of the operator, if the component signals are provided to an antenna system having spatial diversity in the vertical axis.

Likewise, the invention allows the radiation pattern to be controlled in the horizontal axis also, if component signals are arranged to be provided to an antenna system having spatial diversity in the horizontal axis.

The problems of the prior art, as discussed above, are avoided by means of this invention, as the phase and amplitude control and adjustment is done at

According to another aspect of the invention there is provided a method of controlling the direction of a transmit beam produced by an antenna connected to at least two base stations, the method comprising:

in a first base station, splitting a first signal to be transmitted into a plurality of component signals;

applying a complex weight or weights to at least one of the component signals, thereby changing the phase and/or amplitude of the component signal relative to at least one other of the component signals;

passing the component signals to amplifying and combining means wherein the signals are brought to a power level suitable for transmission, and combining the component signals with component signals from a second base station using combining and filtering means;

passing the combined component signals to antenna elements or groups of elements, such that transmission by the elements causes a beam of energy representative of the first signal to be formed in a direction governed by the complex weight or weights;

measuring at least one of said component signals in the vicinity of the antenna using a measuring receiver, and passing information relating to the measurement through a data hub to the basestation.

According to a further aspect of the invention there is provided 11. A method of controlling the direction of a receive beam produced by an antenna connected to at least two base stations, the method comprising:

i) receiving in the antenna a plurality of component signals, each relating to a receiving element or group of receiving elements, and passing the signals to splitting and filter means via a plurality of feeder cables;

ii) separating using the splitting and filter means the component signals intended for a first base station, and amplifying said component signals using amplification means;

iii) applying a complex weight or weights to at least one of the component signals in the first base station, thereby changing the phase and/or amplitude of the component signal relative to at least one other of the component signals;

iv) combining the component signals in a beamformer in the first base station to produce a receive beam formed in a direction governed by the complex weight or weights;

v) feeding a signal from a signal generator to one or more feeder cables in the vicinity of the antenna, and measuring the properties of the received signal at the basestation;

vi) repeating steps ii to v in a second basestation independently of the first base station.

Claims

1. A base station for communicating signals between an operator and one or more mobile units by means of an antenna system having a plurality of radiating elements, wherein:

the system is arranged to process the signals as a plurality of component signals, each component signal being associated with one or more radiating elements within the antenna system, and

modulating means are arranged to apply complex weights to the component signals such that summation of the component signals results in the production of an antenna beam direction dependent on the value of the complex weights, and

wherein splitting, combining, and component signal amplifying means is provided between the application of the complex weight to the component signal and the component signal passing through its associated radiating element or elements,

characterised in that:

the splitting and combining means incorporates an interface allowing other operators to be connected simultaneously to the same antenna system, with each operator operating on a different frequency, and the system further includes a measurement receiver, and a data hub, wherein the measurement receiver is adapted to take a complex measurement from any component signals in the vicinity of the antenna system and generated by any basestation connected to the antenna system, and to pass the measurement to the generating basestation via the data hub, to enable phase component signal phase correction due to changes in feeder length between the basestation and the antenna.

2. A base station as claimed in claim 1 wherein the measurement receiver is arranged to be switchable between different component signals in the vicinity of the antenna system.

3. A base station as claimed in claim 1 or claim 2 arranged to apply the complex weights to the component signals at a component signal frequency lower than the component signal frequency that is passed to the antenna.

4. A base station as claimed in any of claims 1 to 3 wherein the base station is arranged to apply the complex weights to the component signals at a component signal frequency substantially the same as the component signal frequency that is passed to the antenna.

5. A base station as claimed in any of claims 1 to 4 wherein the modulating means comprises vector controllers.

6. A base station as claimed in claim 5 wherein the vector controllers are arranged to control the relative phase of each component signal.

7. A base station as claimed in claim 5 or claim 6 wherein the vector controllers are arranged to control the amplitude of the component signal.

8. A plurality of basestations connected to a single antenna system, wherein each basestation is a basestation as claimed in claim 1.

9. A method of controlling the direction of a transmit beam produced by an antenna connected to at least two base stations, the method comprising:

in a first base station, splitting a first signal to be transmitted into a plurality of component signals;

applying a complex weight or weights to at least one of the component signals, thereby changing the phase and/or amplitude of the component signal relative to at least one other of the component signals;

passing the component signals to amplifying and combining means wherein the signals are brought to a power level suitable for transmission, and combining the component signals with component signals from a second base station using combining and filtering means;

passing the combined component signals to antenna elements or groups of elements, such that transmission by the elements causes a beam of energy representative of the first signal to be formed in a direction governed by the complex weight or weights;

measuring at least one of said component signals in the vicinity of the antenna using a measuring receiver, and passing information relating to the measurement through a data hub to the basestation.

10. A method as claimed in claim 9 wherein the signals generated by the second base station are independent from those generated by the first base station.

11. A method of controlling the direction of a receive beam produced by an antenna connected to at least two base stations, the method comprising:

i) receiving in the antenna a plurality of component signals, each relating to a receiving element or group of receiving elements, and passing the signals to splitting and filter means via a plurality of feeder cables;

ii) separating using the splitting and filter means the component signals intended for a first base station, and amplifying said component signals using amplification means;

iii) applying a complex weight or weights to at least one of the component signals in the first base station, thereby changing the phase and/or amplitude of the component signal relative to at least one other of the component signals;

iv) combining the component signals in a beamformer in the first base station to produce a receive beam formed in a direction governed by the complex weight or weights;

v) feeding a signal from a signal generator to one or more feeder cables in the vicinity of the antenna, and measuring the properties of the received signal at the basestation;

vi) repeating steps ii to v in a second basestation independently of the first base station.